Warn-on-Forecast: Progress and Plans

Norman Weather Forecast Office
Gabe Garfield
2/23/11

Overview

- Progress
  - Acquired local WRF
  - Hired liaison to Hazardous Weather Testbed
  - Performed configuration tests for OUN WRF
  - Developed social science survey

Overview

- Plans
  - Run more WRF configuration tests
  - Use ADAS in OUN WRF
  - Participate in Spring Experiment
    - OUN WRF
    - Survey
    - IT support
  - Conduct social science project
    - "Call-to-action" statements

Overview

- Collaborations
  - CAPS
    - Employing ADAS in the OUN WRF
  - SSWIM, OCS, NSSL
    - Social science project - evaluating "call-to-action" statements

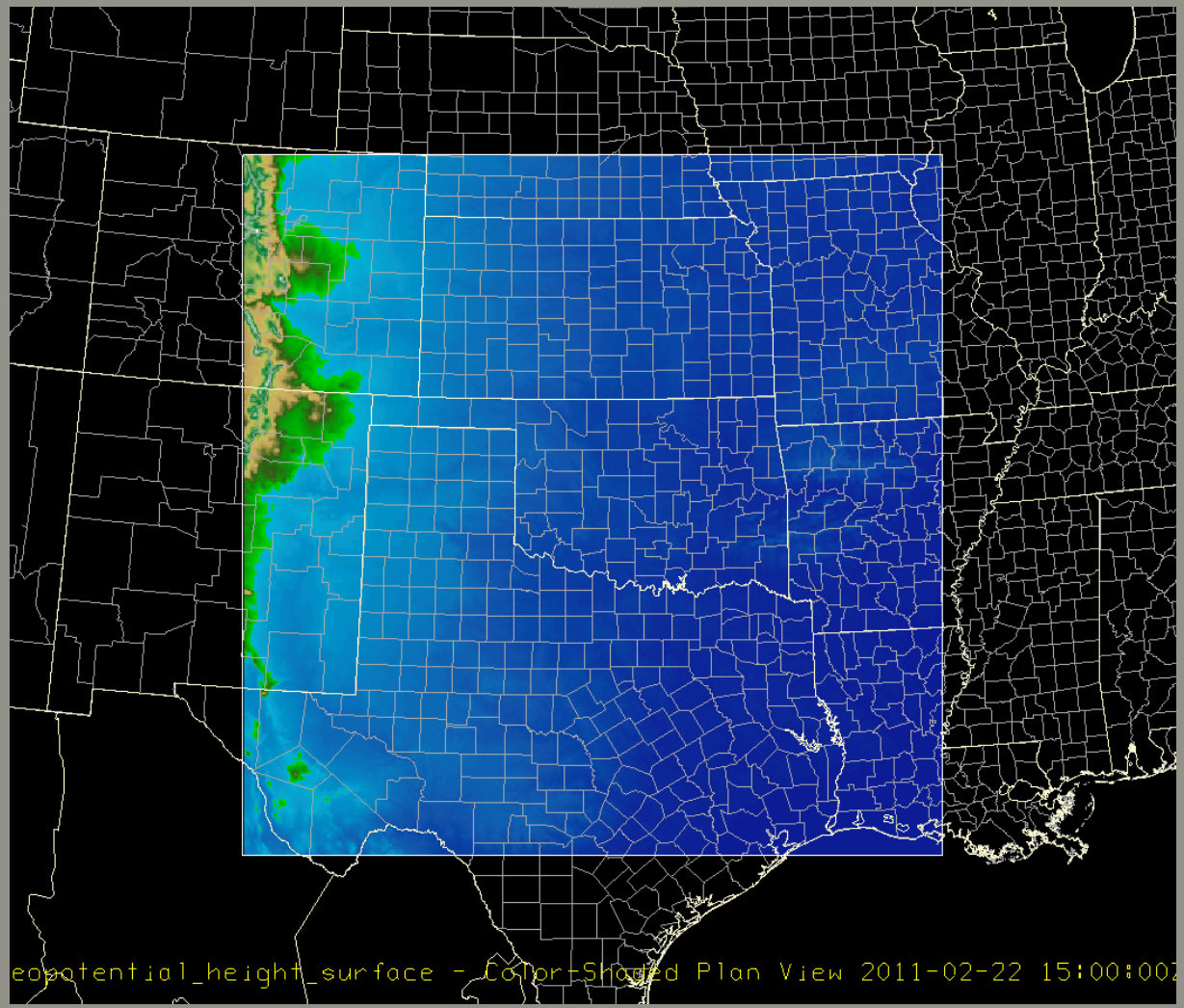
The OUN WRF

- Computational cluster with 10 nodes and 80 processor cores
  - Each core is an Intel E5620 (2.4 GHz)
- InfiniBand communication link between nodes (20 Gbit/s)
- WRF Version 3.1.1
- Runs every hour out to 8 hours

The OUN WRF

- Advanced Research WRF (ARW) solver
- 3-km grid-spacing
- 1296 x 1296 km domain centered on OUN

The OUN WRF

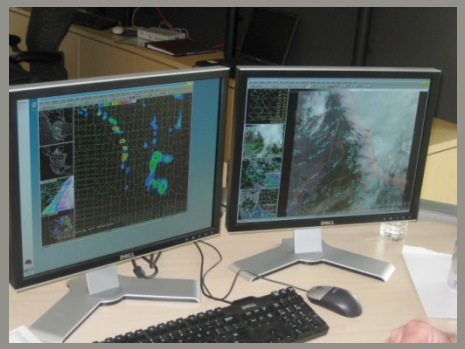

eopotential_height_surface - Color-Shaded Plan View 2011-02-22 15:00:00

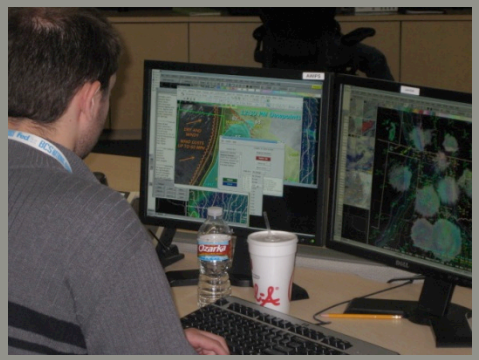
The OUN WRF

- Boundary conditions:
  - 12Z WRF forecast
- Initial conditions:
  - Local Analysis and Prediction System (LAPS) analysis
- "Hot starts" through LAPS

The OUN WRF

- Goals:
  - Begin to use adaptable high-resolution model in operational framework
  - Instruct forecasters in benefits and limitations of using high-resolution output
  - Provide guidance for other NWS offices in best practices





WRF Configuration: Sensitivity Tests

- Bulk Microphysics Parameterizations (BMP)
  - Comparison of parameterizations
  - Initialization time tests

Bulk Microphysics Parameterizations

- Snook and Xue (2007) found that tornadogenesis in their simulations depended on the microphysics parameterization.
- Dawson et al. (2007) found that double-moment schemes improve forecasts significantly for grid-spacing less than 1 km.
  - Double-moment schemes may not provide much advantage for coarser resolutions

Bulk Microphysics Parameterizations

- Millbrandt and Yau (2006d) found that biggest forecast improvement is change from single to double-moment microphysics.
- Why? There are several atmospheric processes in which mixing ratio and number concentration are independent (Dawson et al. 2010)
  - Accretion
  - Diffusion
  - Evaporation
  - Sedimentation

Microphysics

- 10 microphysics schemes in the WRF
- Investigated 8 (minus Thompson schemes)

Convective Cases

- September 15, 2010
- October 10, 2010
- December 31, 2010

Convective Cases

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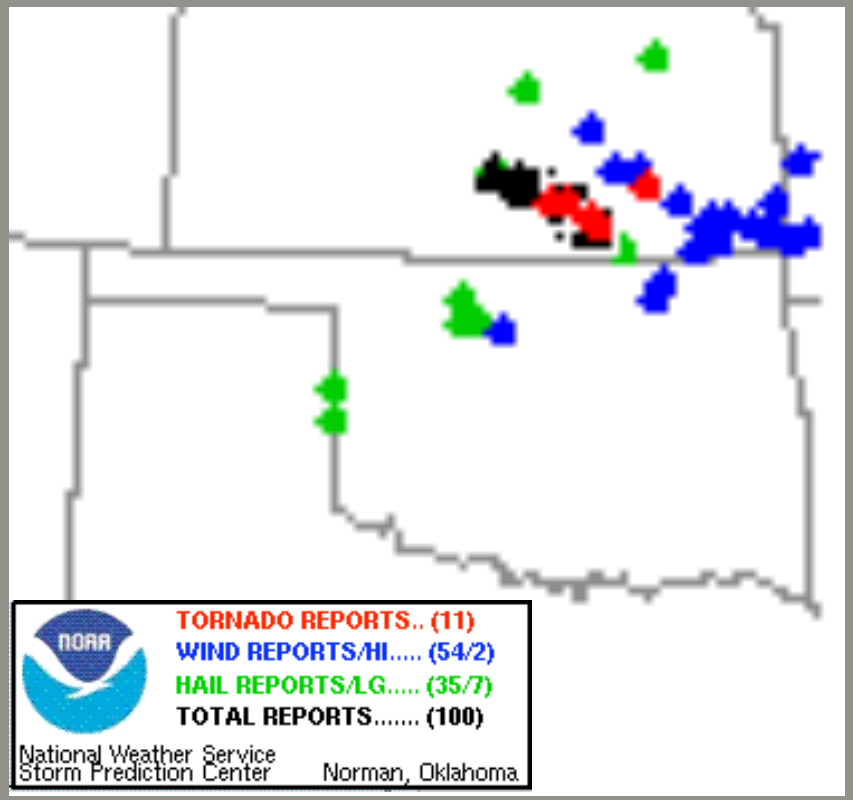
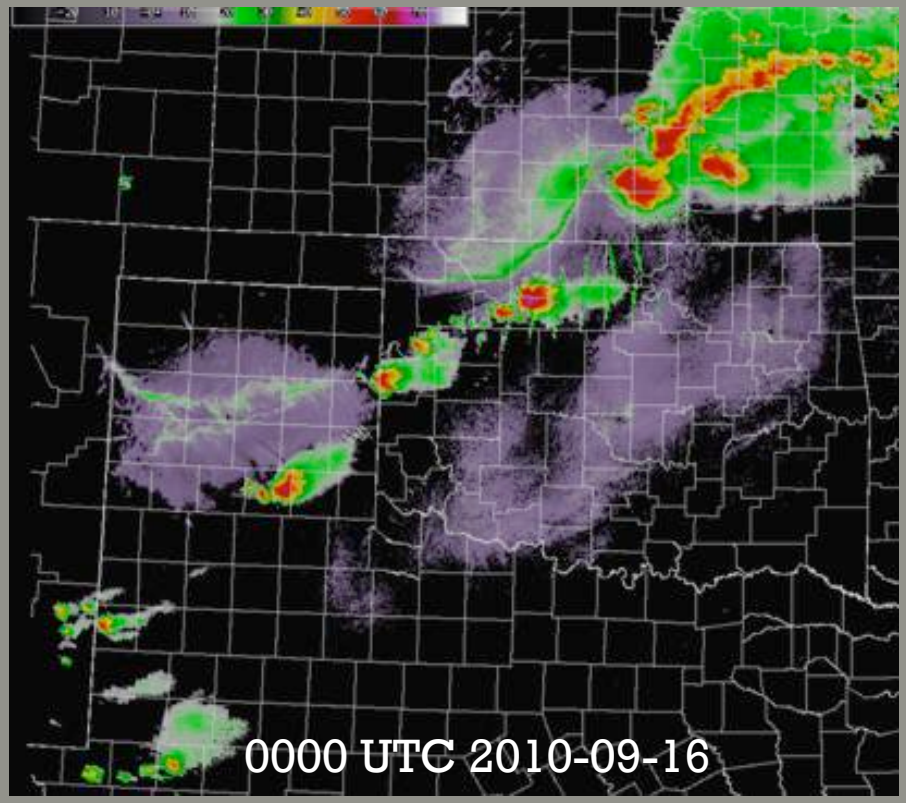
Storm Reports

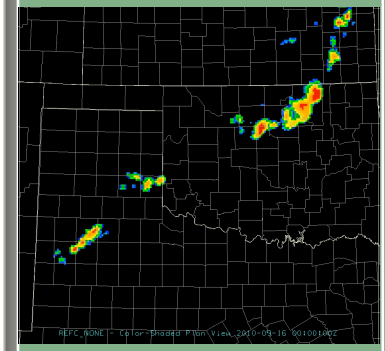


Composite Reflectivity



Microphysics

0000 UTC, 9/16/10, 7-HR FORECAST



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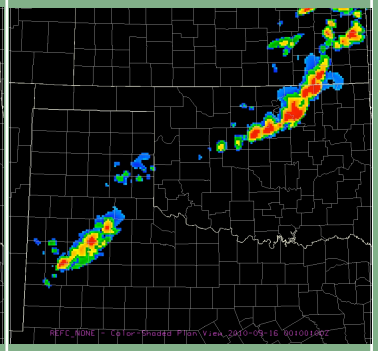

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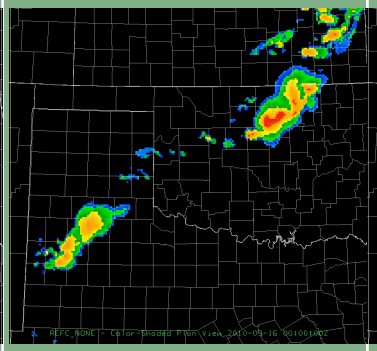
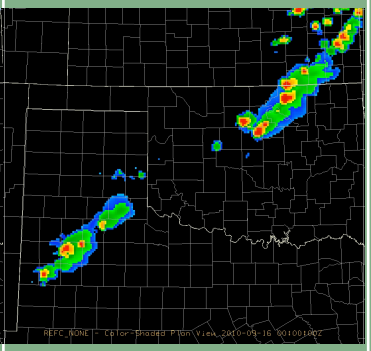
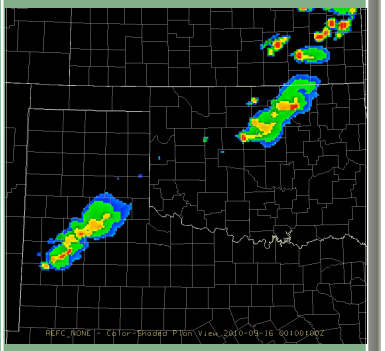


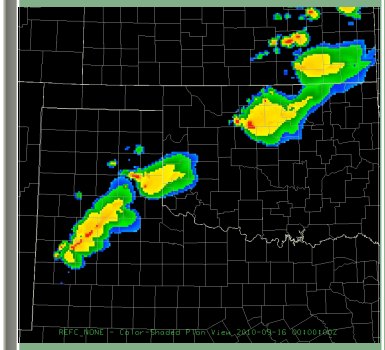
Ferrier



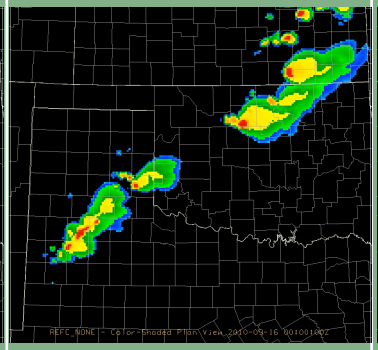
Goddard



Morrison



WSM 3



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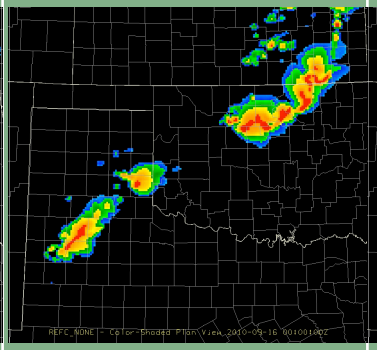

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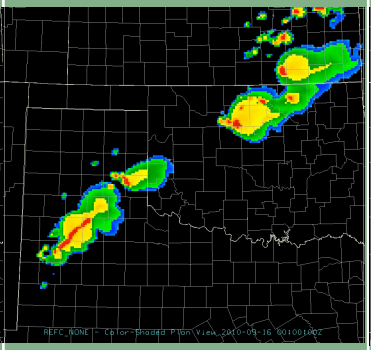

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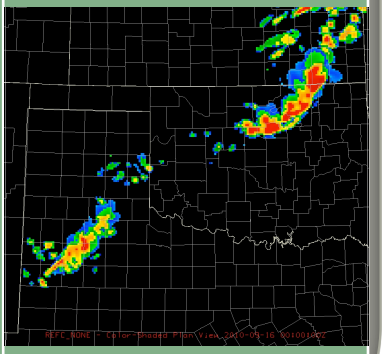

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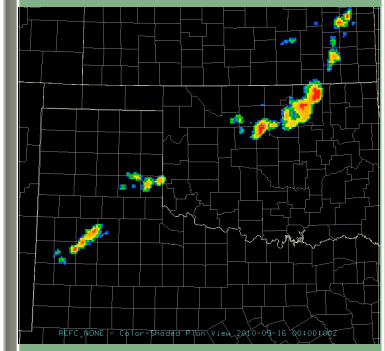
Microphysics

0000 UTC, 9/16/10, 7-HR FORECAST



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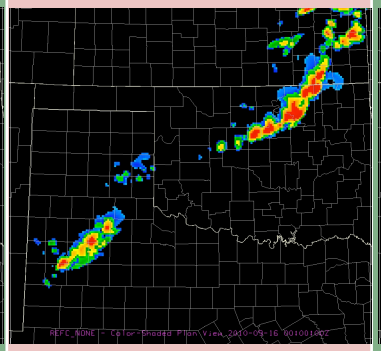

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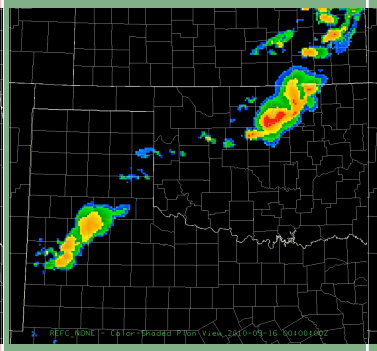

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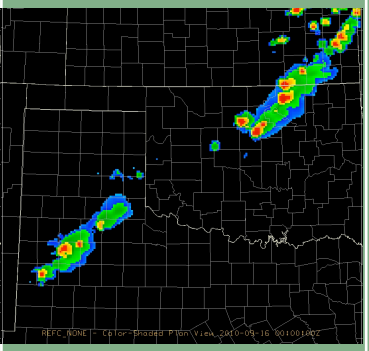

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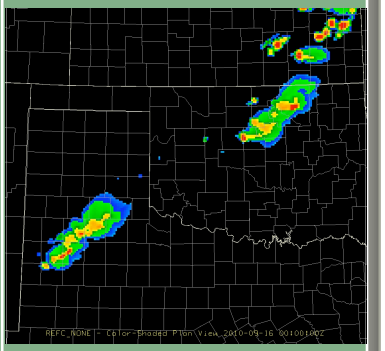

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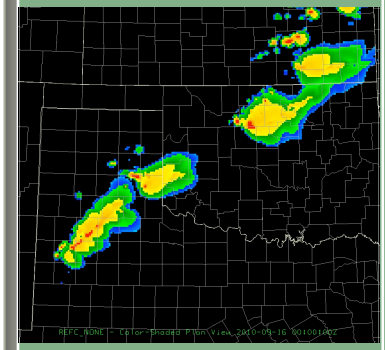

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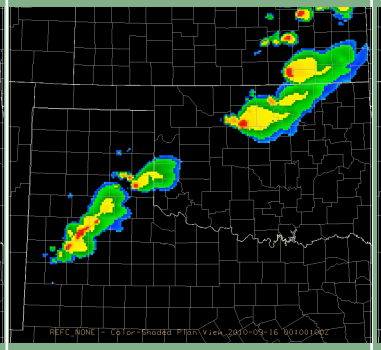

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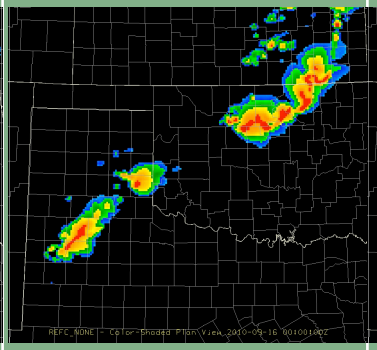

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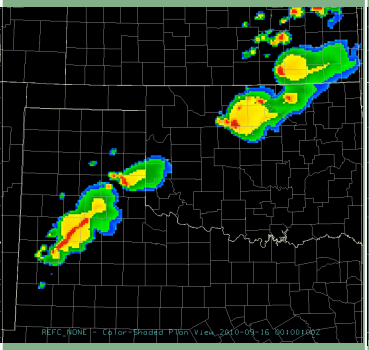

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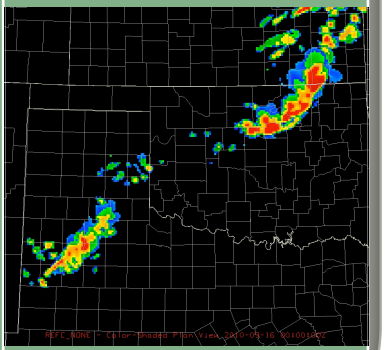

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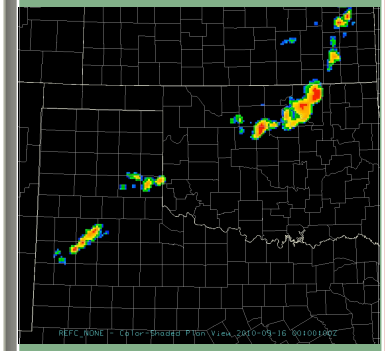

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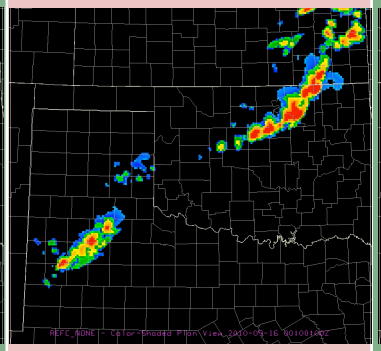

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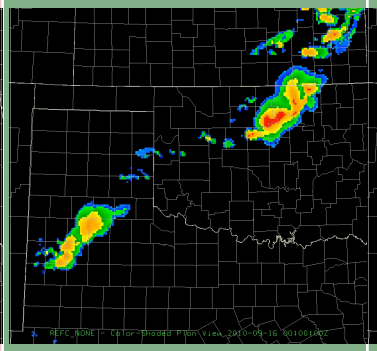

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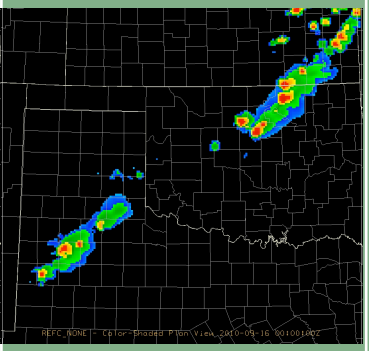

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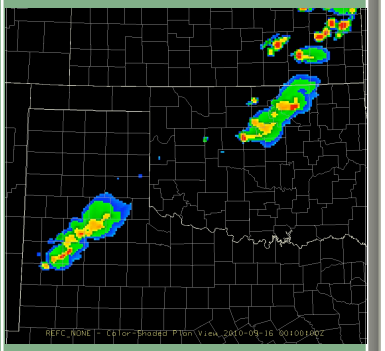

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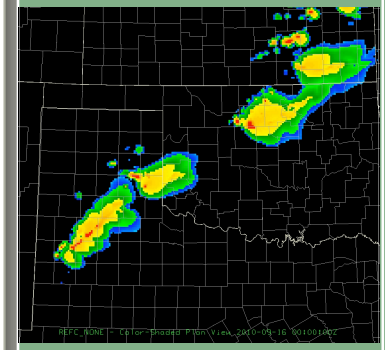

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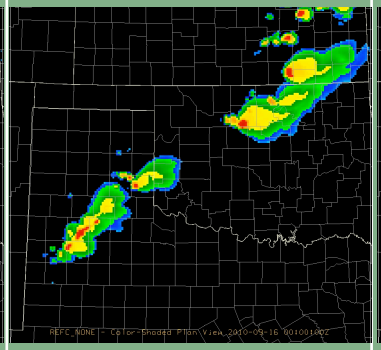

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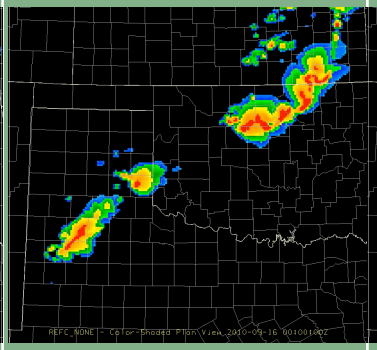

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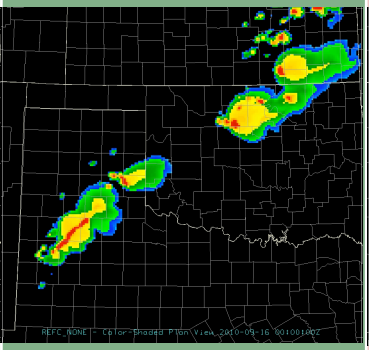

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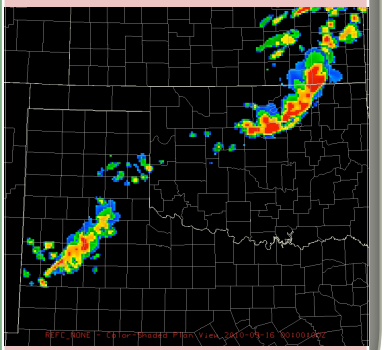
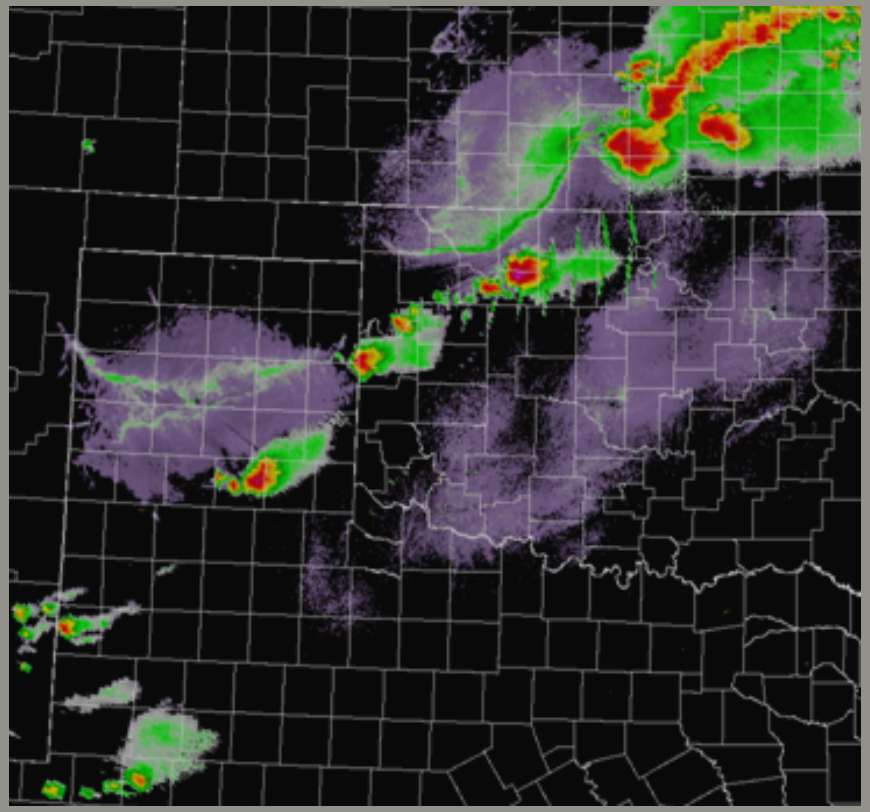


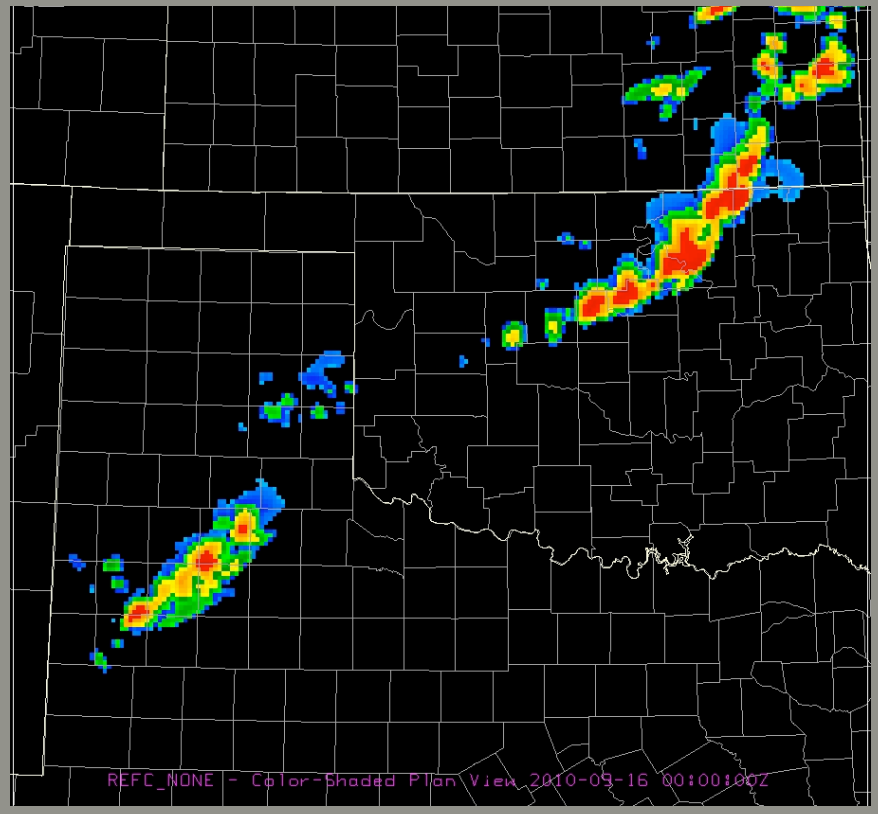
WDM 6

Top Performers

0000 UTC, Composite Reflectivity



0000 UTC, Lin Microphysics



Top Performers

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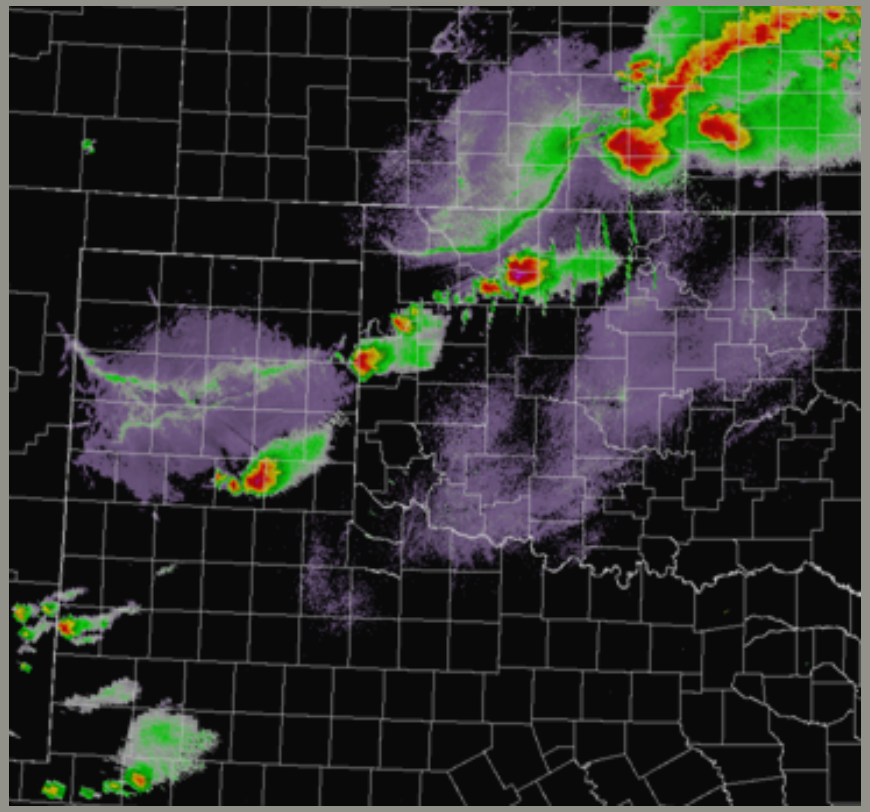
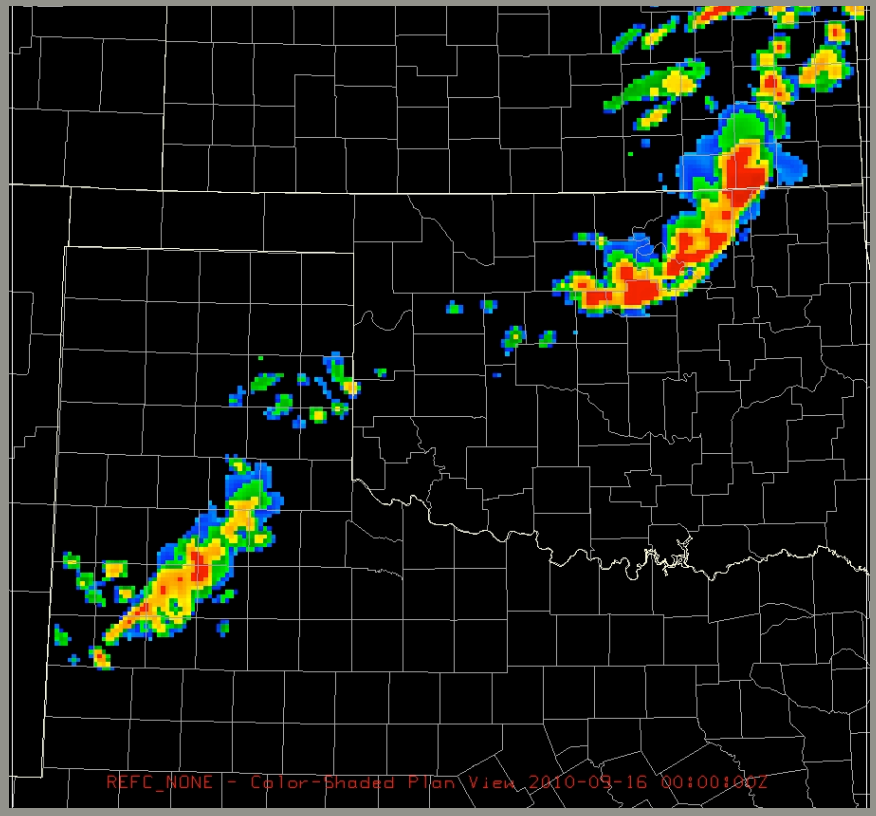


0000 UTC, WDM 6 Microphysics



Poor Performer

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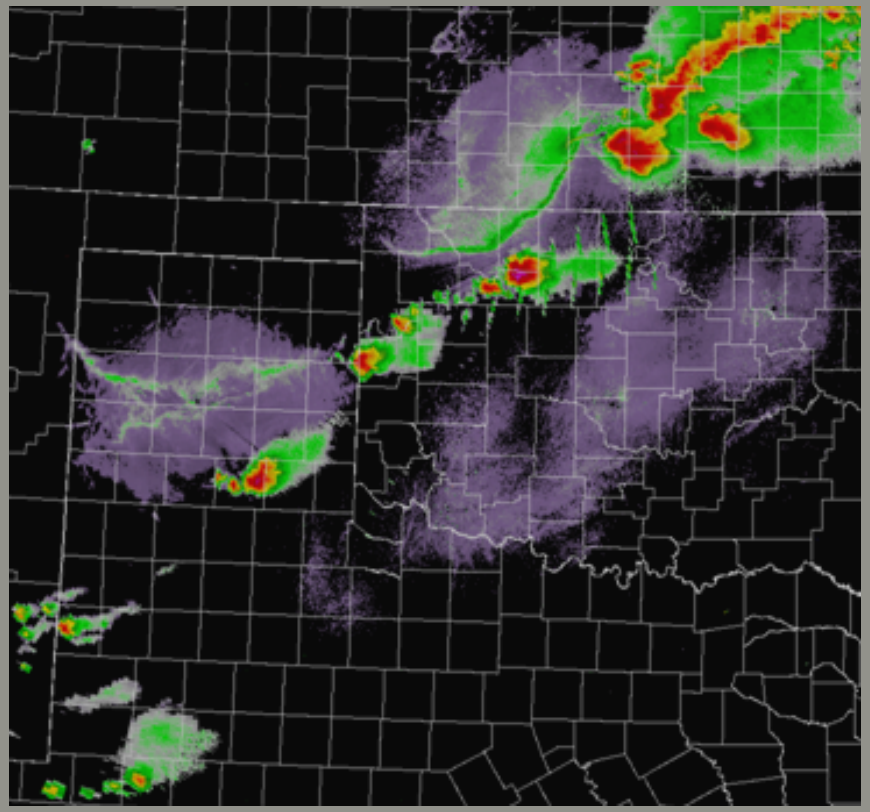
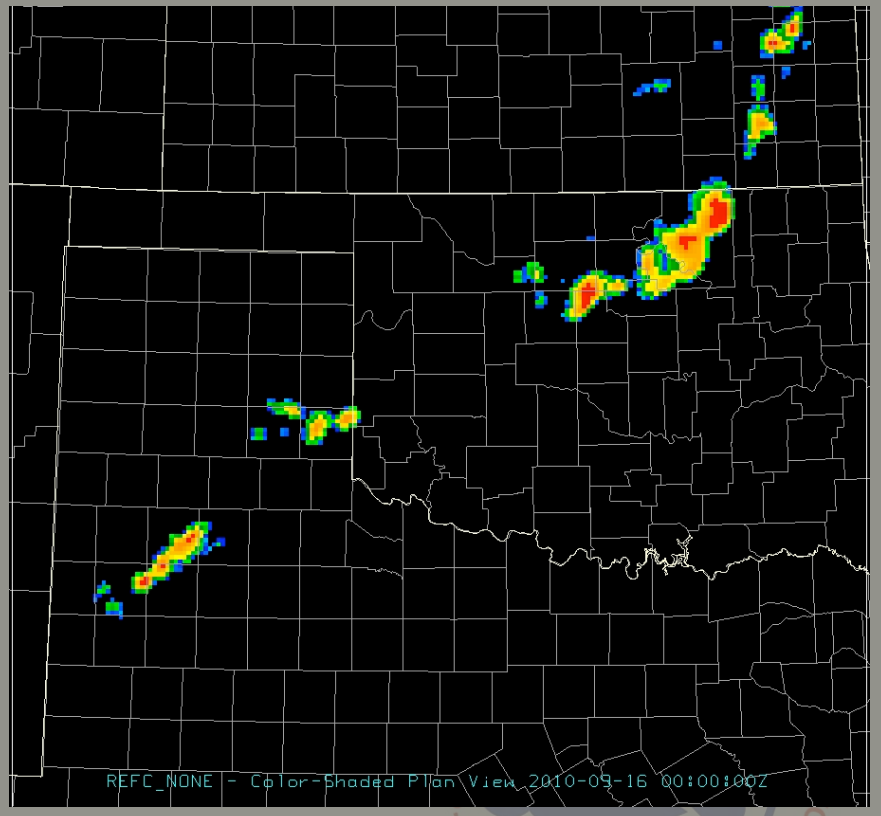


0000 UTC, Kessler Microphysics



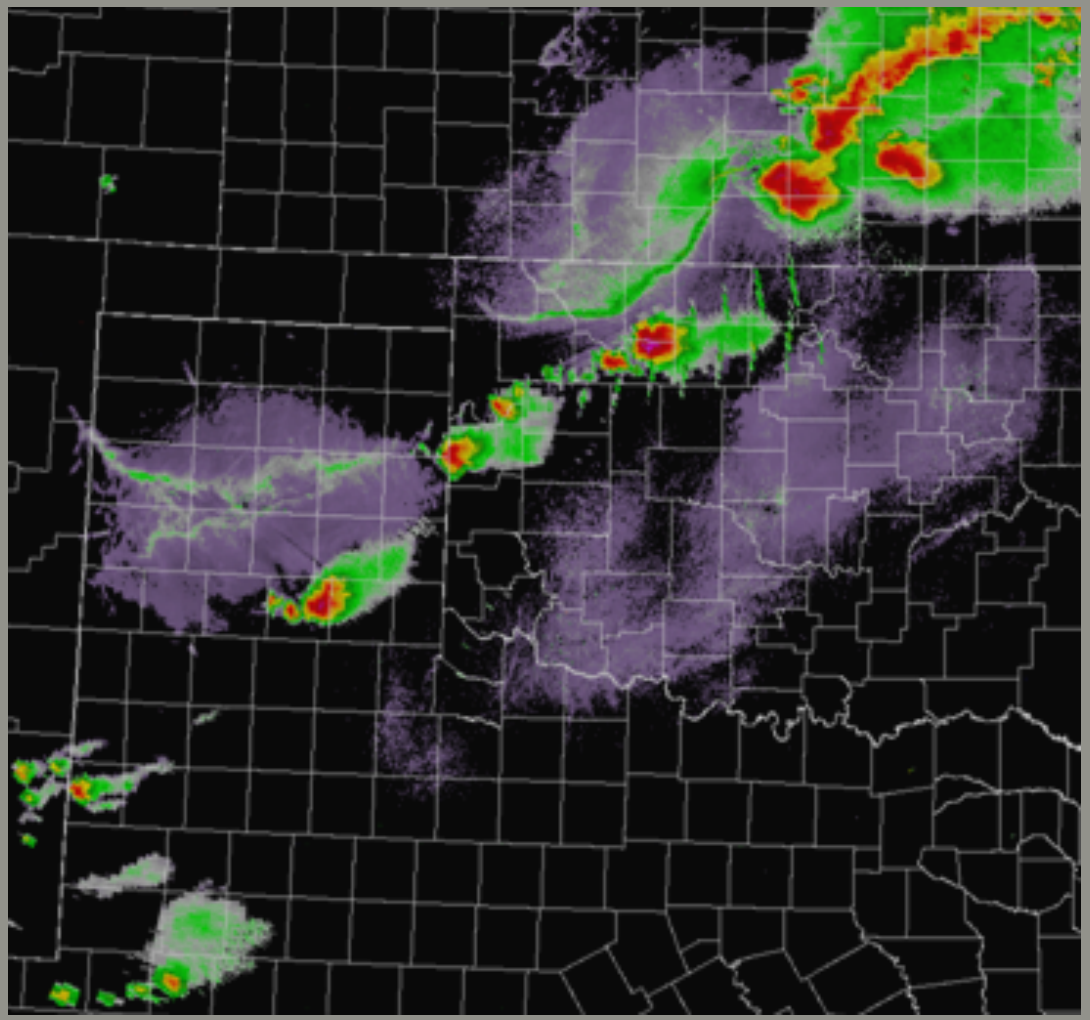
9/15/10

- Lin and WDM6 microphysics performed best.
- Model initialized at 17 UTC
  - Some studies show forecasts >6 hrs unreliable
  - What initialization time is most accurate?

Initialization Sensitivity

WSR-88D

2010-09-16
0000 UTC



Initialization Sensitivity

WDM6
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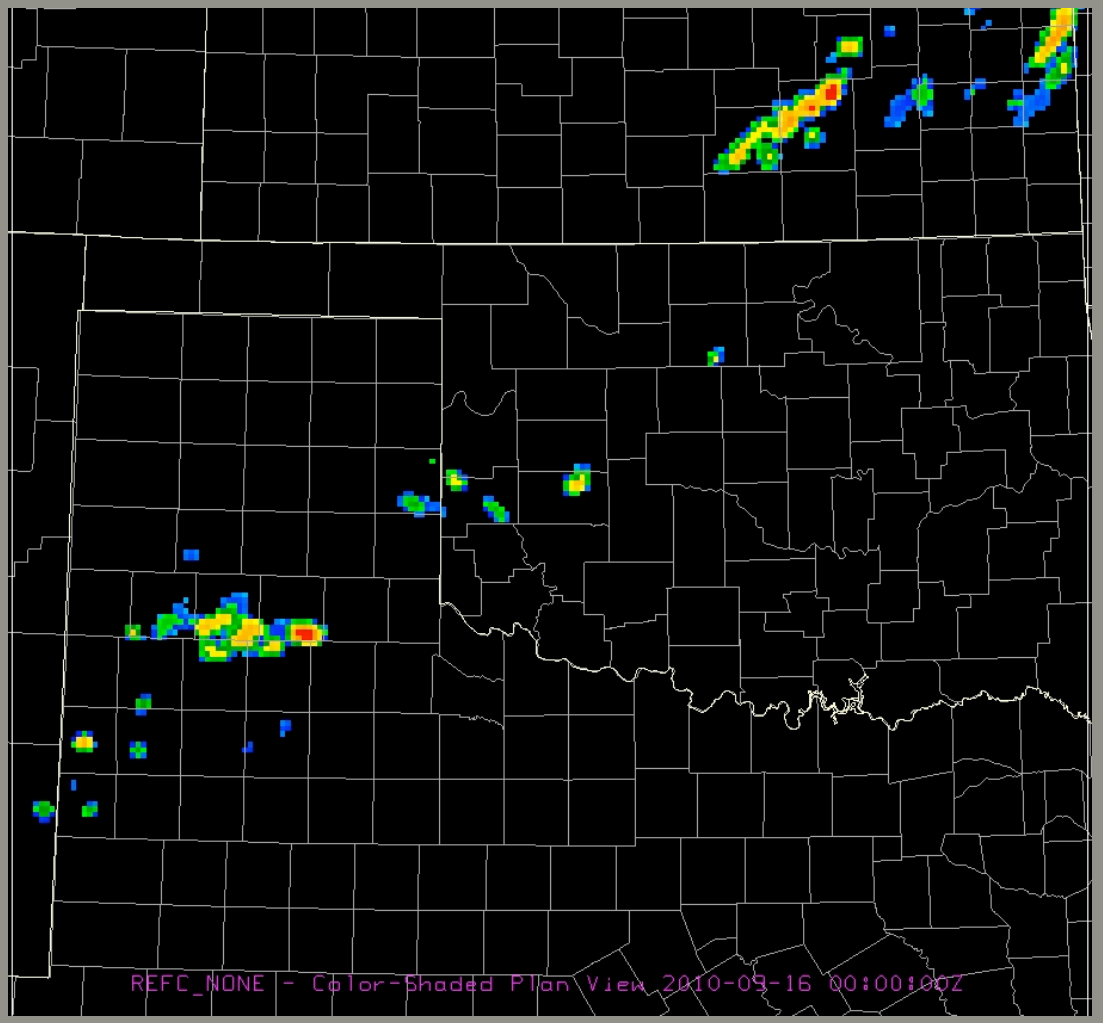
2010-09-16
0000 UTC



Initialization Sensitivity

WDM6
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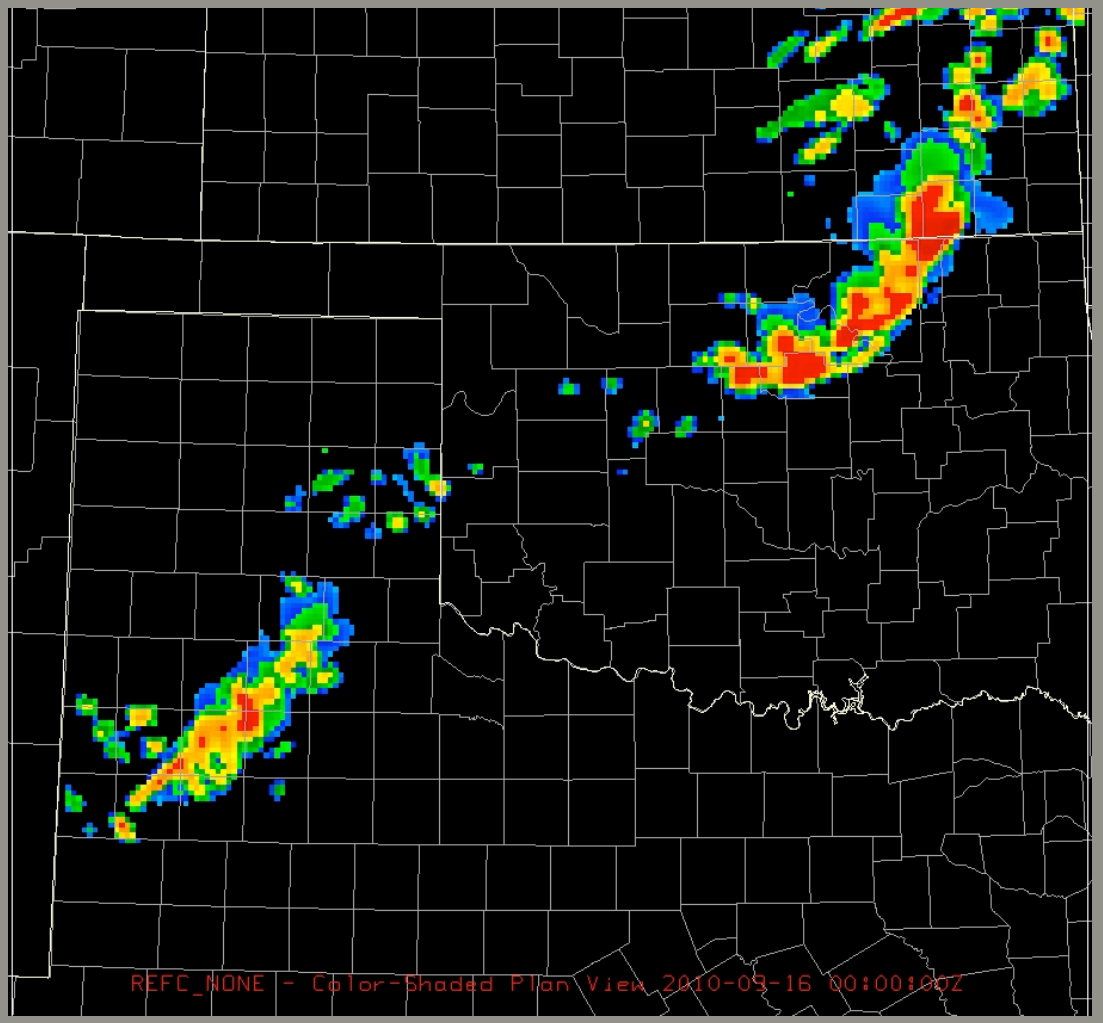
2010-09-16
0000 UTC



Initialization Sensitivity

WDM6
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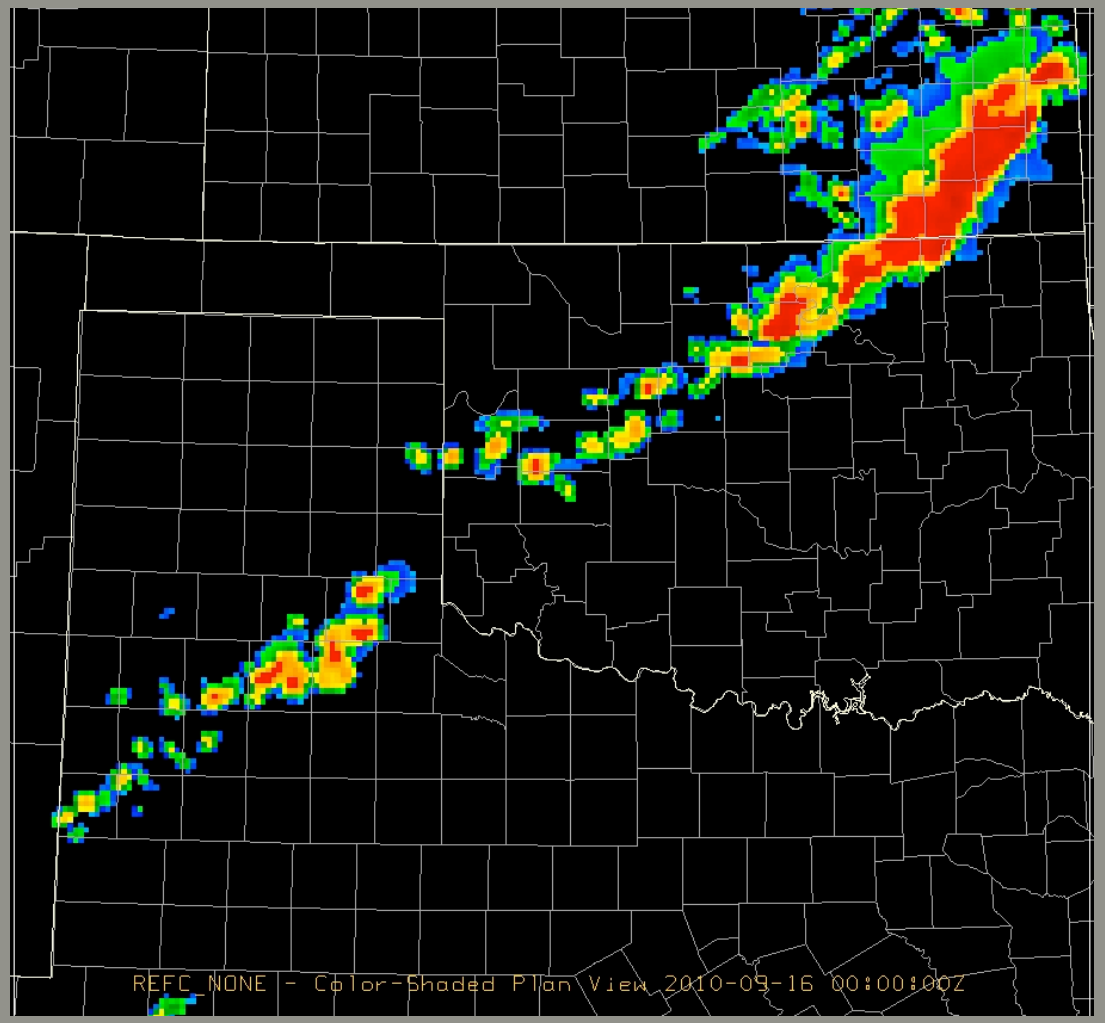
2010-09-16
0000 UTC



Initialization Sensitivity

WDM6
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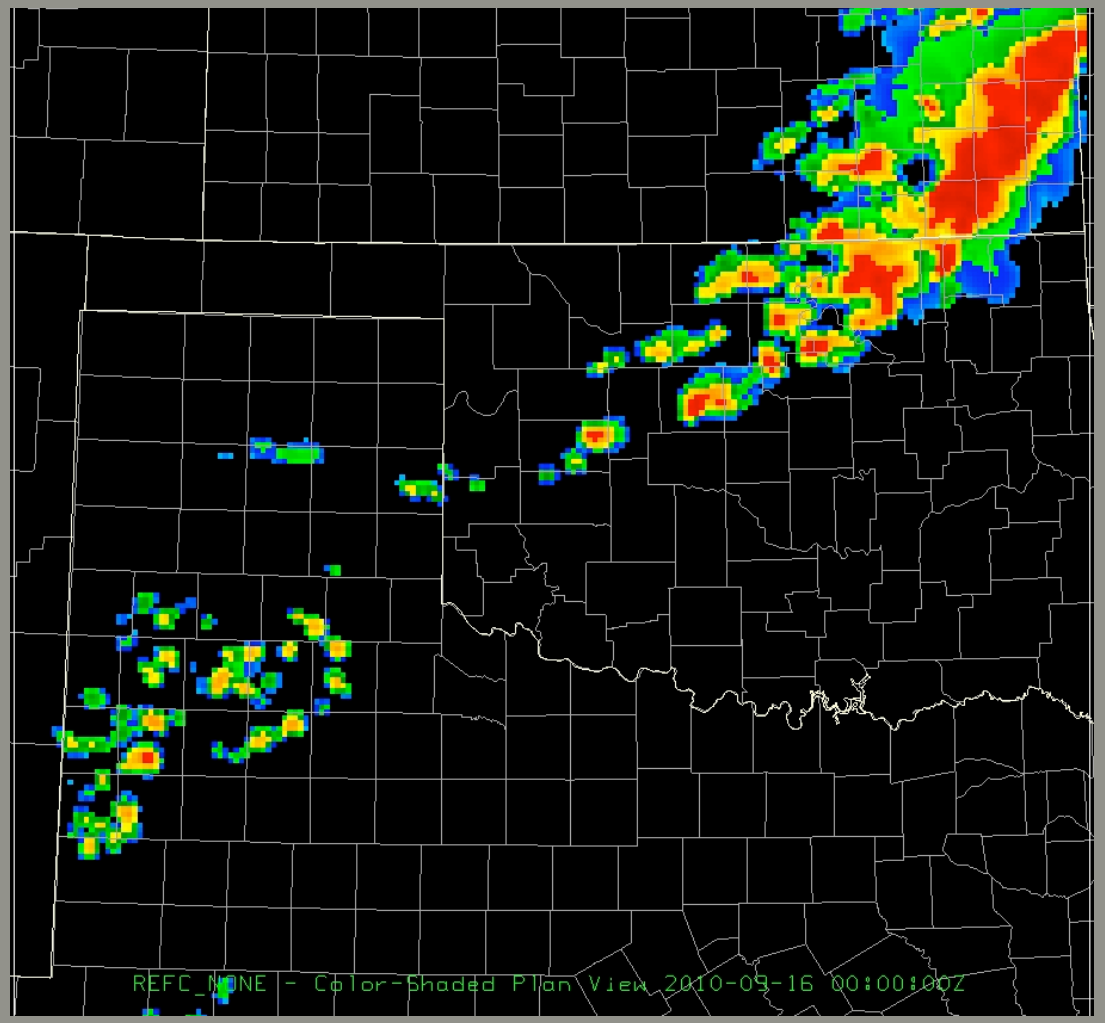
2010-09-16
0000 UTC



Initialization Sensitivity

WDM6
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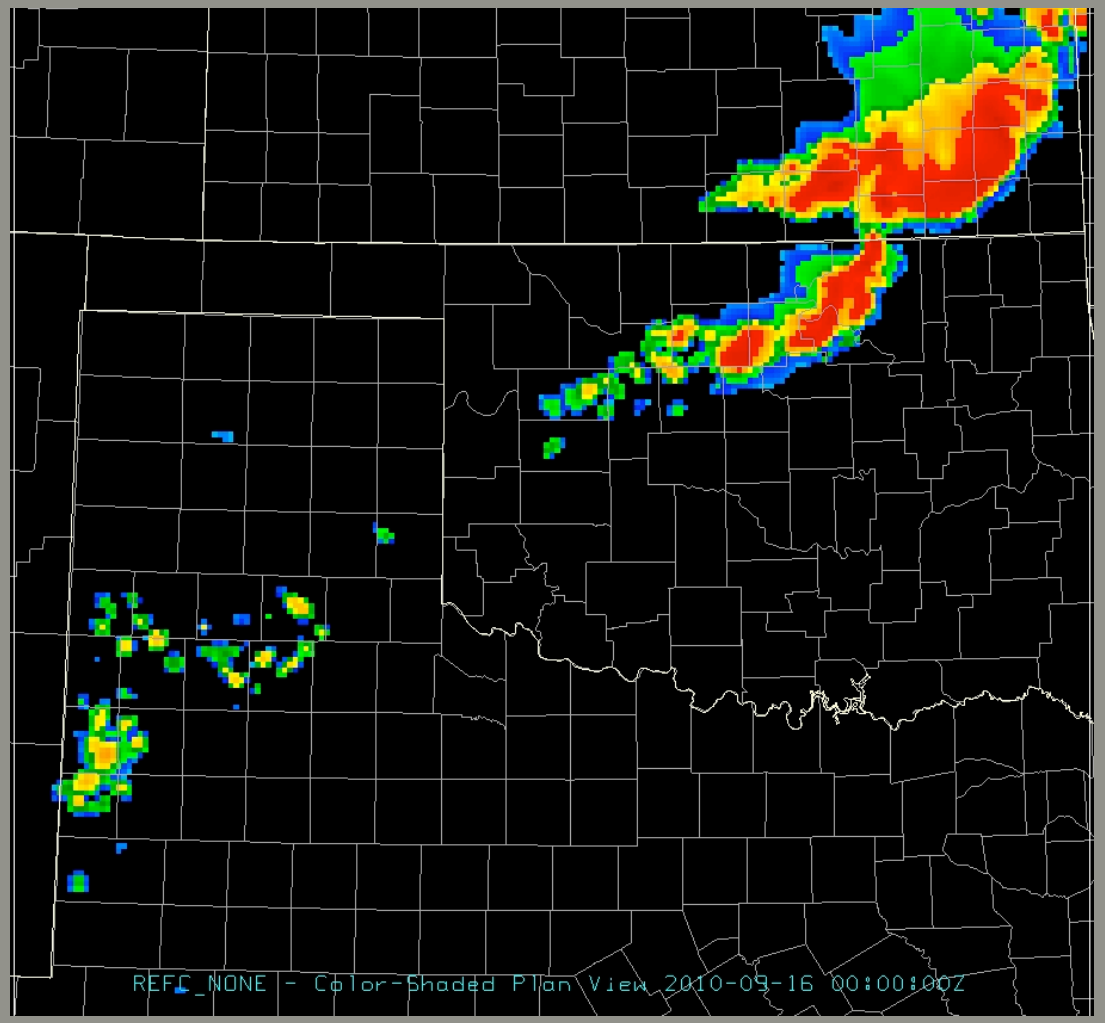
2010-09-16
0000 UTC



Initialization Sensitivity

WDM6
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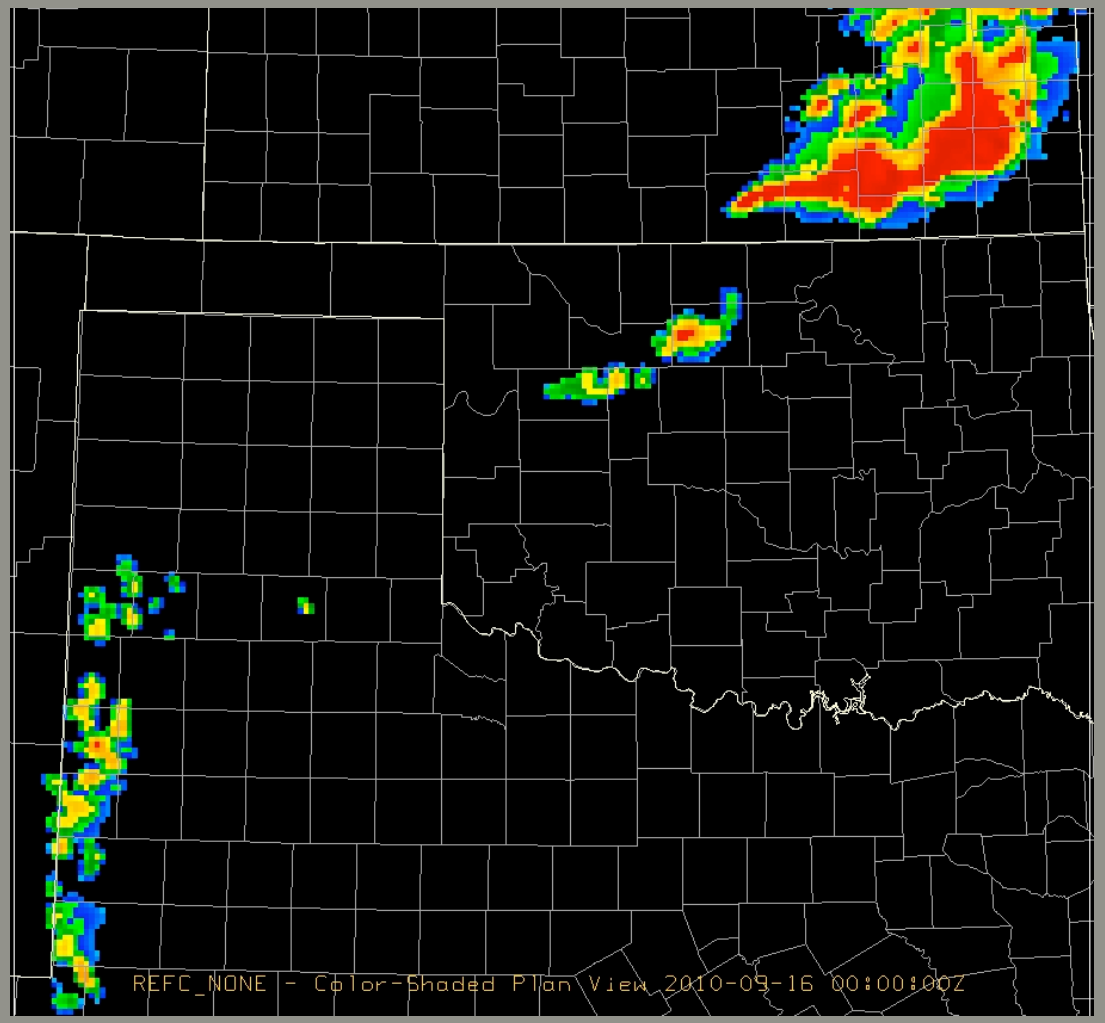
2010-09-16
0000 UTC



Initialization Sensitivity

WDM6
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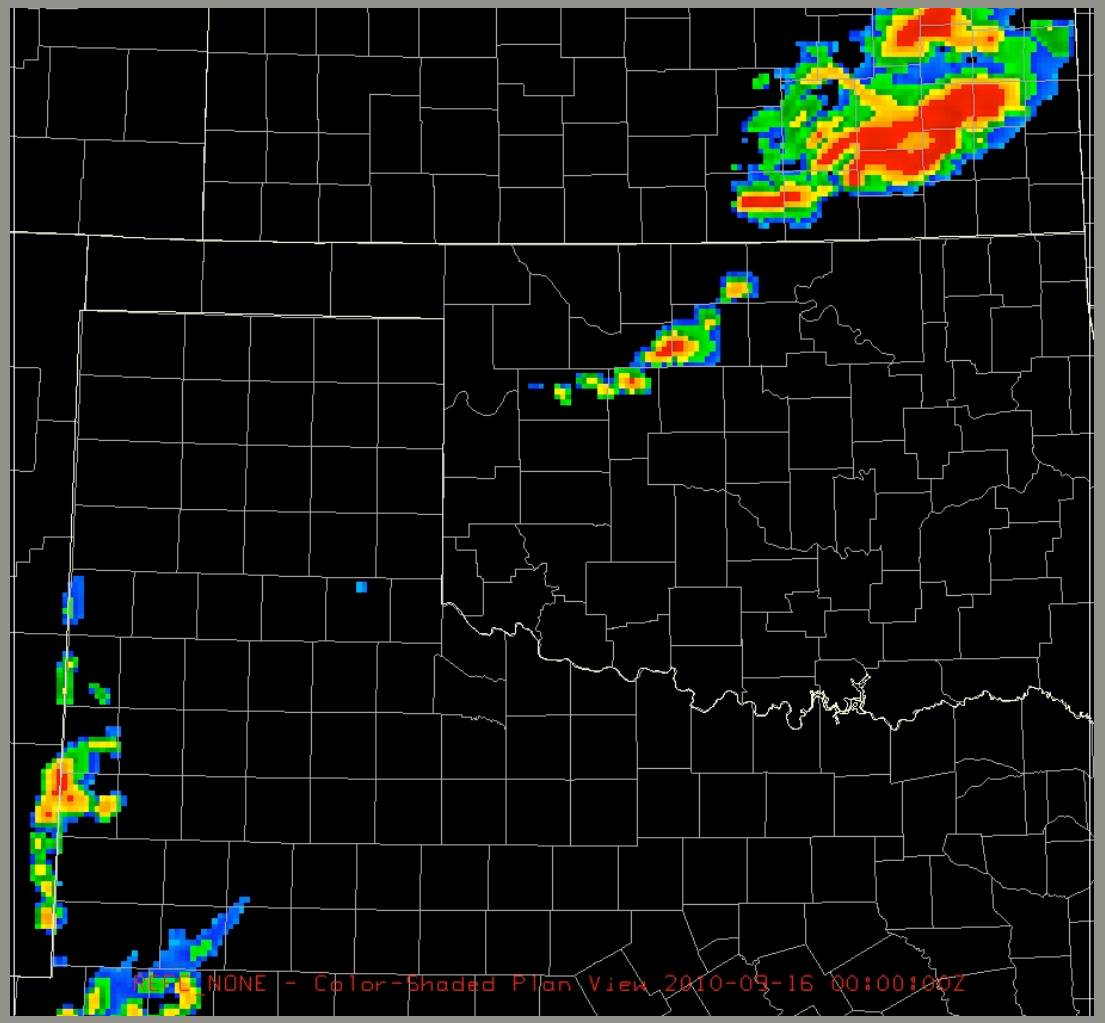
2010-09-16
0000 UTC



Initialization Sensitivity

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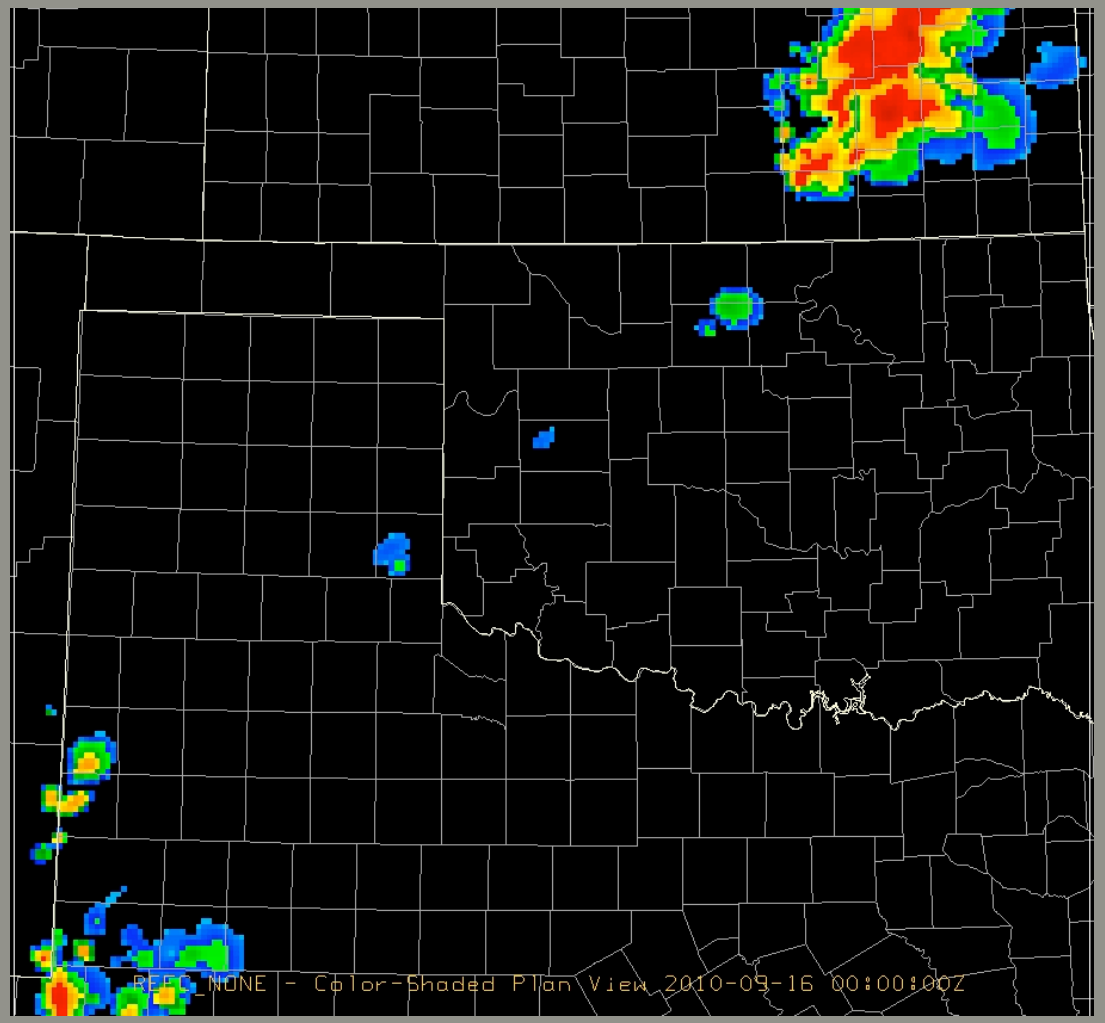

Initialization Sensitivity

WSR-88D

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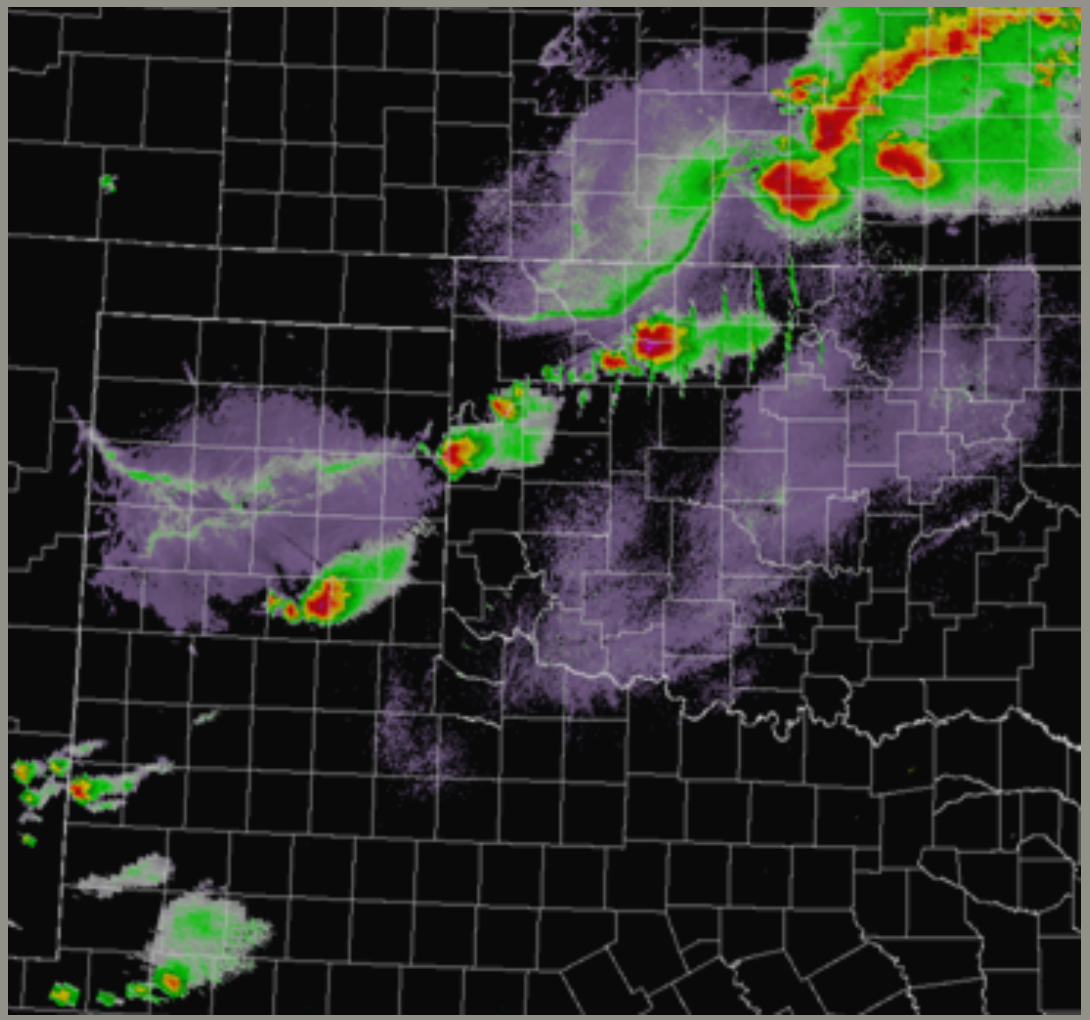


9/15/10

- Lin and WDM6 microphysics performed best.
- The 2100 and 2200 UTC initialization times produced best results.
- Other cases?

Convective Cases

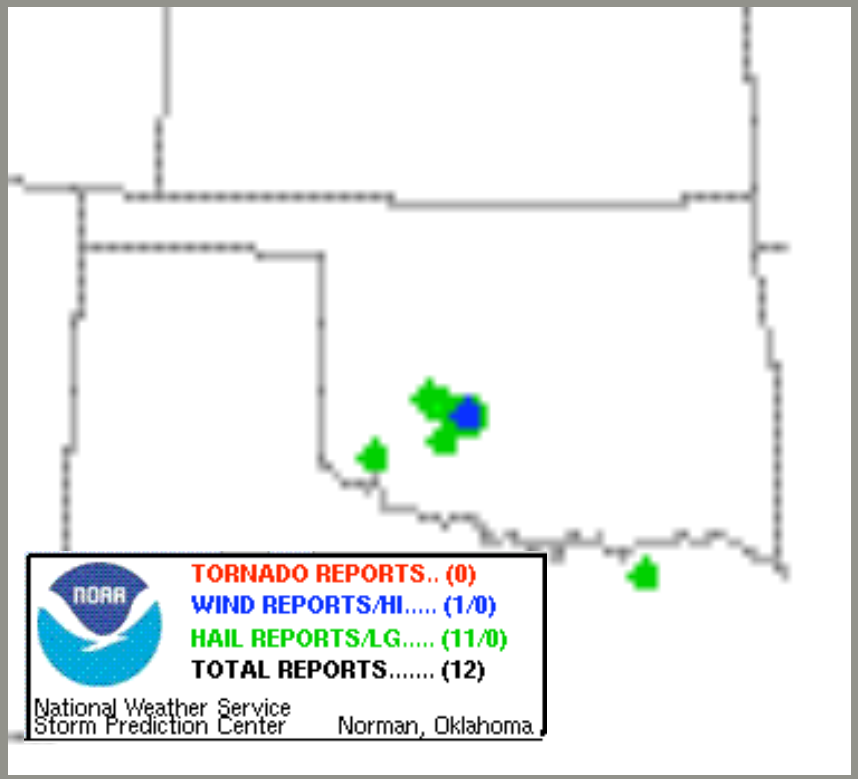
- September 15, 2010
- October 10, 2010
- December 31, 2010

Convective Cases

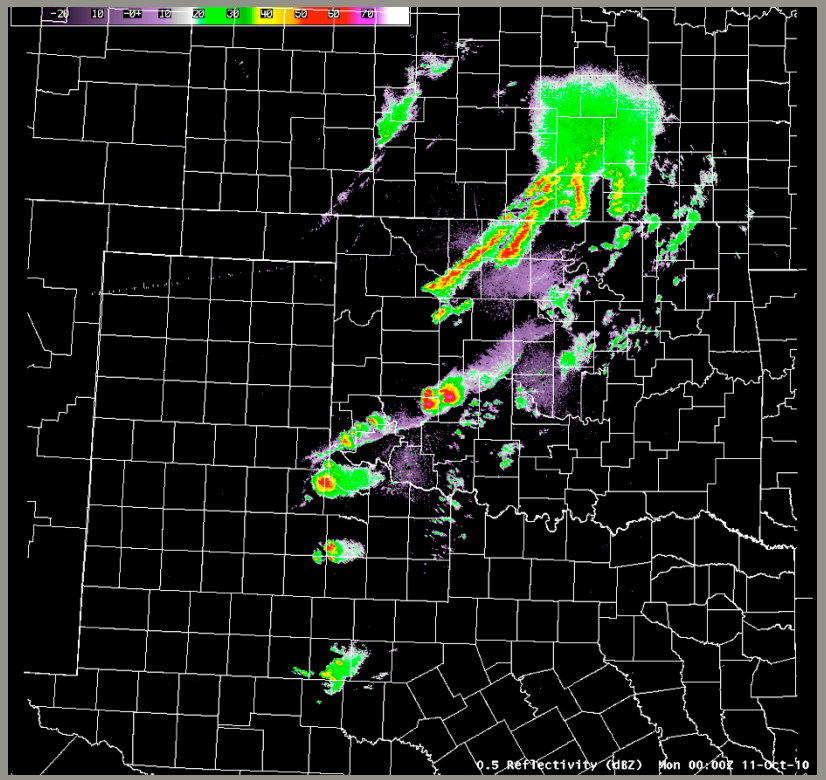
- September 15, 2010
- October 10, 2010
- December 31, 2010

10/10/10

Storm Reports

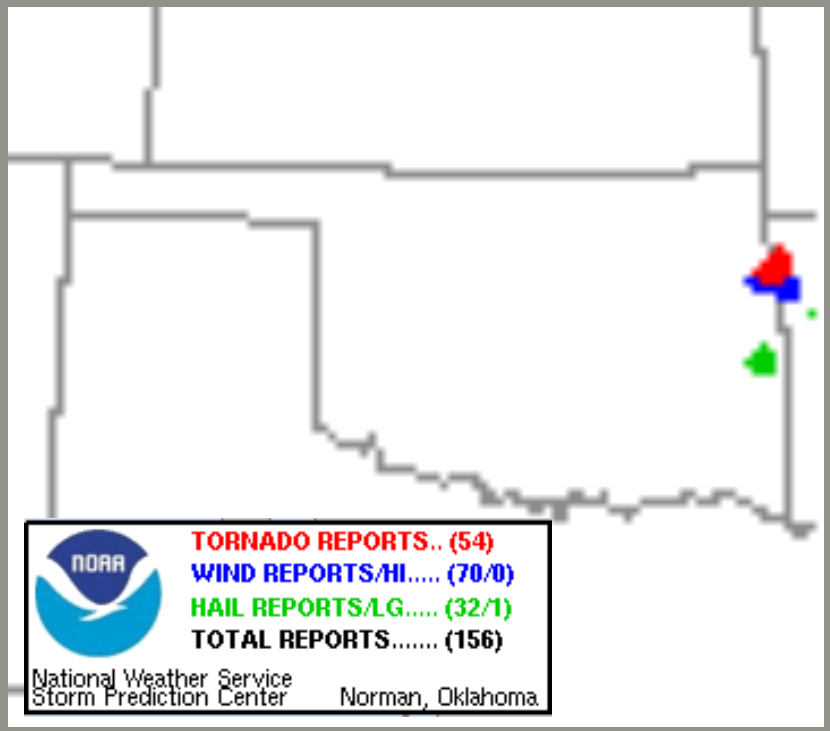


Composite Reflectivity
0000 UTC 10/11/10



12/31/10

Storm Reports



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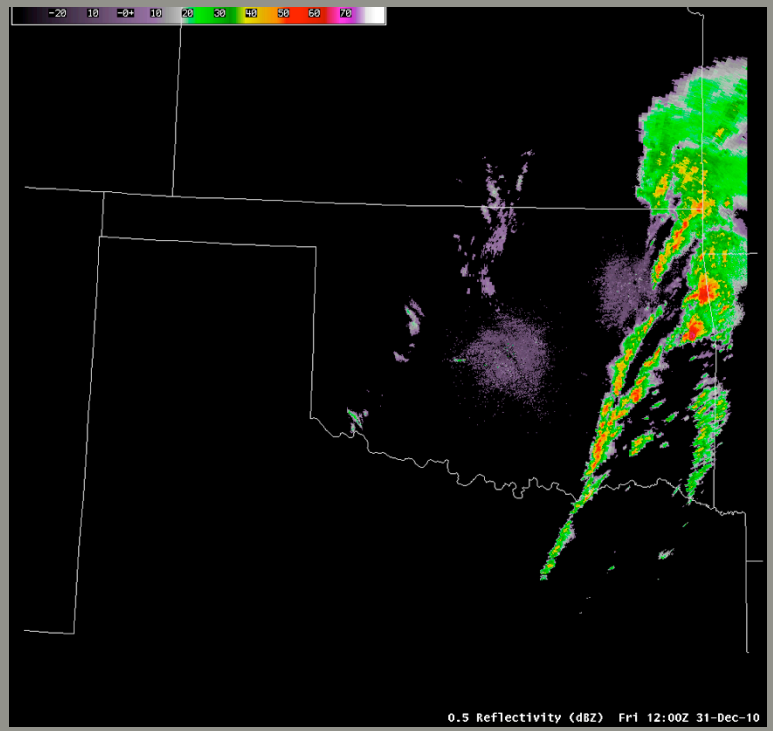


Other Cases

- 10/10/2010
  - Lin and WDM6 microphysics performed best again
- 12/31/2010
  - Best parameterization unclear

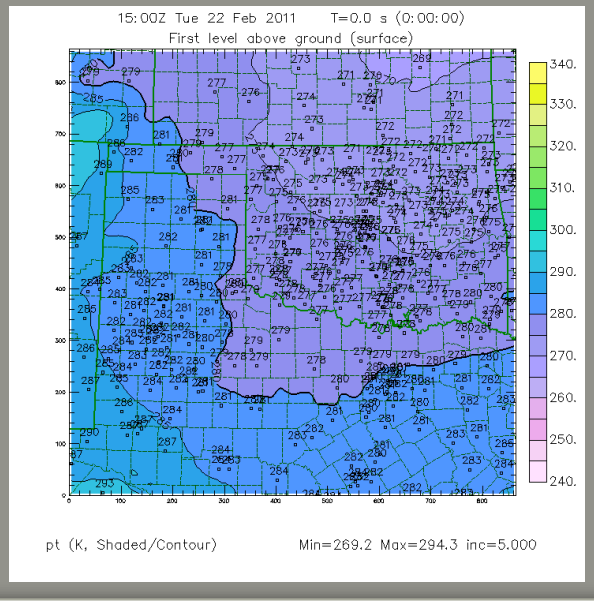
Note: Compared with 3-hr forecast for these cases.

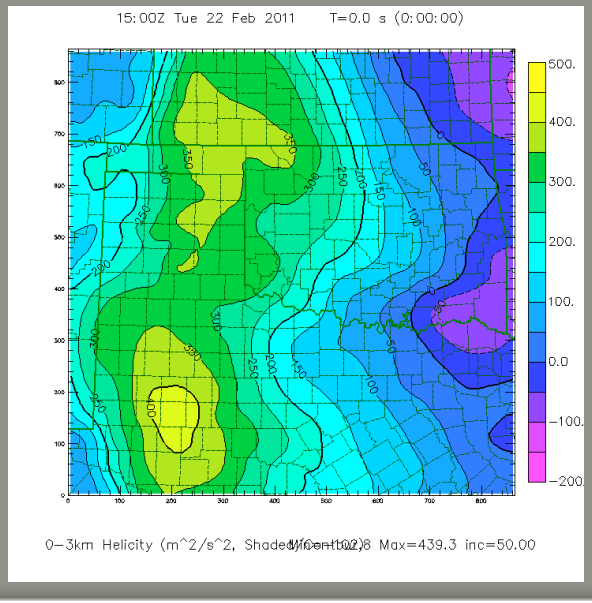
Model Specifications

Parameterization	Scheme
Cumulus	None
Microphysics	WRF Double-Moment 6-species
Planetary Boundary Layer	Yonsei University
Land-Surface Model	NOAH
Longwave Radiation	Rapid Radiative Transfer Model
Shortwave Radiation	Dudhia Scheme

OUN WRF: Data Assimilation

- Currently using the Local Analysis and Prediction System for data assimilation
- Investigating ARPS Data Analysis System (ADAS) as replacement (ARPS 5.2.13)





OUN WRF: Data Assimilation

- ADAS
  - 3D-VAR analysis
  - Ingests data from surface obs, profilers, RAOBS, and 25 WSR-88DS
  - Can run 3D-VAR analysis in 7 minutes (no precip echoes)
- Testing ARPS 3D-VAR analysis in WRF 3.2
  - Waiting for convective cases this spring

Spring Experiment

- OUN WRF
  - Provide output to forecasters
- Survey
  - Evaluate OUN WRF performance
- IT support

Social Science

- How can we improve response to warnings?
  - How do people respond to "call-to-action" statements (CTAs)?

F4 tornado damage at Picher, Oklahoma.

Social Science

- New survey to evaluate efficacy of call-to-action statements in tornado warnings.
- Compare current template to new statements based on findings in social science literature.

THE SAFEST PLACE TO BE DURING A TORNADO IS IN A BASEMENT. IF IN A MOBILE HOME...EVACUATE TO A SUBSTANTIAL STRUCTURE. GET UNDER A WORKBENCH OR OTHER PIECE OF STURDY FURNITURE. IF NO BASEMENT IS AVAILABLE...SEEK SHELTER ON THE LOWEST FLOOR OF THE BUILDING IN AN INTERIOR HALLWAY OR ROOM SUCH AS A CLOSET. USE BLANKETS OR PILLOWS TO COVER YOUR BODY AND ALWAYS STAY AWAY FROM WINDOWS.

Social Science

- Respondents will identify the CTA statements that they consider the most life threatening, most likely to cause action, and convey the greatest certainty
- Results will be analyzed and recommendations made for applications in NWS warning operations

Questions?

References

- **Dawson, D.T., M. Xue, J.A. Milbrandt, M.K. Yau, and G. Zhang, 2007**: Impact of multi-moment microphysics and model resolution on predicted cold pool and reflectivity intensity and structures in the Oklahoma tornadic supercell storms of 3 May 1999. *22nd Conf. on Wea. Analy. and Forecasting/18th Conf. on Num. Wea. Prediction.* 10B.2
- **Dawson, D.T., M. Xue, J.A. Milbrandt, M. K. Yau, 2010**: Comparison of evaporation and cold pool development between single-moment and multimoment bulk microphysics schemes in Idealized Simulations of Tornadic Thunderstorms. *Mon. Wea. Rev.*, **138**, 1152–1171.
- **Milbrandt, J. A., and M. K. Yau, 2005**: A multimoment bulk microphysics parameterization. Part II: A proposed three-moment closure and scheme description. *J. Atmos. Sci.*, **62,** 3065–3081.
- **Snook, N., and M. Xue, 2008**: Effects of microphysical drop size distribution on tornadogenesis in supercell thunderstorms, *Geophys. Res. Lett.*, 35, L24803, doi:10.1029/2008GL035866.